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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/657,505	09/08/2003	Chii-Ming Wu	TS01-1247	9336
42717	7590	10/26/2005	EXAMINER	
HAYNES AND BOONE, LLP 901 MAIN STREET, SUITE 3100 DALLAS, TX 75202			KENNEDY, JENNIFER M	
			ART UNIT	PAPER NUMBER
			2812	

DATE MAILED: 10/26/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/657,505

Applicant(s)

WU ET AL.

Examiner

Jennifer M. Kennedy

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --
Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 25 July 2005.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-51 is/are pending in the application.
- 4a) Of the above claim(s) 4, 17 and 25-51 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-3, 5-16, 18-24 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input checked="" type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date <u>12/03</u> . | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Election/Restrictions

Applicant's election with traverse of claims 1-3, 5-16, and 18-24 in the reply filed on July 25, 2005 is acknowledged. The traversal is on the ground(s) that the species are not patentably distinct. This is not found persuasive because the examiner notes that the claimed the species are mutually exclusive and therefore are patentably distinct. The examiner notes in the restriction requirement sent March 10, 2005 it was stated:

Should applicant traverse on the ground that the species are not patentably distinct, applicant should submit evidence or identify such evidence now of record showing the species to be obvious variants or clearly admit on the record that this is the case. In either instance, if the examiner finds one of the inventions unpatentable over the prior art, the evidence or admission may be used in a rejection under 35 U.S.C. 103(a) of the other invention.

Applicant has not submitted evidence or admitted on the record that the species are obvious variants. Therefore it is held that the species are patentably distinct. The requirement is still deemed proper and is therefore made FINAL.

Claims 4, 17, and 25-51 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected species, there being no allowable generic or linking claim.

Claim Objections

Claim 5 is objected to because of the following informalities: The claim recites 500 to 10000 standard centimeters per minute (sccm). The examiner believes this

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should be changed to -- 500 to 10000 standard **cubic** centimeters per minute (sccm) -- or -- 500 to 10000 standard centimeters **cubed** per minute (sccm) -- in order for it to be a volumetric flow rate. Appropriate correction is required. The examiner also request Applicant's cooperation with changing any instances of this typographical error in the Specification.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1-3, 10-16, and 24 are rejected under 35 U.S.C. 102(b) as being anticipated by Raaijmakers et al. (U.S. Patent Appl. 2001/0054769).

In re claim 1, Raaijmakers et al. disclose an atomic layer deposition (ALD) process for depositing a metal nitride layer comprised of a plurality of metal nitride monolayers on a substrate, comprising:

- (a) providing a substrate with a patterned layer formed thereon (50 and/or 56);
- (b) loading the substrate in an ALD process chamber and adjusting the temperature and pressure in said ALD process chamber to acceptable levels (see [0071] and [0126]);

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(c) flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant is deposited on said substrate (see [0126]-[0132], Table II and [0086]);

(d) purging said ALD process chamber with an inert gas to leave a monolayer of nitrogen containing reactant on said substrate (see [0126]-[0132], Table II);

(e) flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer([0126]-[0132], Table II);

(f) purging said ALD process chamber to remove unreacted metal precursor [0126]-[0132], Table II); and

(g) repeating the sequence of steps (c), (d), (e), (f) until an acceptable thickness of metal nitride layer is reached [0126]-[0132], Table II).

In re claim 2, Raaijmakers et al. disclose the method wherein the temperature of said ALD process chamber is between about 250°C and 750°C and the pressure in said ALD process chamber is maintained in a range from about 0.1 to 50 Torr 9 see [0126] and Table II)

In re claim 3, Raaijmakers et al. disclose the method wherein said metal precursor is $\text{Ti}(\text{OCH}(\text{CH}_3)_2)_4$, tetrakis(dimethylamido)titanium (TDMAT), tetrakis(diethylamido)titanium (TDEAT), or tert-butyylimino-tris(diethylamino)tantalum (TBTDET) (see [0115]).

In re claim 10, Raaijmakers et al. disclose the method wherein the film thickness of the metal nitride layer is between 0 and about 50 nm (see [0154]-[0155]).

In re claim 11 Raaijmakers et al. disclose an atomic layer deposition (ALD) process for depositing a metal nitride layer comprised of a plurality of metal nitride monolayers on a substrate, comprising:

- (a) providing a substrate with a patterned layer formed thereon (50 and/or 56);
- (b) loading the substrate in an ALD process chamber and adjusting the temperature and pressure in said ALD process chamber to acceptable levels (see [0071] and [0126]);
- (c) flowing a metal precursor into said ALD process chamber, so that metal precursor is deposited on said substrate (see [0126]-[0132], Table II);
- (d) purging said ALD process chamber with an inert gas to leave a monolayer of metal precursor on said substrate (see [0126]-[0132], Table II);
- (e) flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant reacts with said metal precursor monolayer to give a metal nitride monolayer on said substrate (see [0126]-[0132], Table II and [0086]);
- (f) purging said ALD process chamber to remove unreacted nitrogen containing reactant [0126]-[0132], Table II); and
- (g) repeating the sequence of steps (c), (d), (e), (f) until an acceptable thickness of metal nitride layer is reached [0126]-[0132], Table II).

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In re claim 12, Raaijmakers et al. disclose a method of forming metal nitride layer on a substrate, said substrate comprised of an upper dielectric layer having at least one opening, comprising:

(a) providing a substrate with an upper dielectric layer that has a pattern formed being comprised of at least one opening (56);

(b) loading the substrate in an ALD process chamber and adjusting the temperature and pressure in said ALD process chamber to acceptable levels (see [0071] and [0126]);

(c) flowing a metal precursor into said ALD process chamber, so that metal precursor is deposited on said substrate (see [0126]-[0132], Table II);

(d) purging said ALD process chamber with an inert gas to leave a monolayer of metal precursor on said substrate (see [0126]-[0132], Table II);

(e) flowing a nitrogen containing reactant into said ALD process chamber so that said nitrogen containing reactant reacts with said metal precursor monolayer to give a metal nitride monolayer on said substrate (see [0126]-[0132], Table II and [0086]);

(f) purging said ALD process chamber to remove unreacted nitrogen containing reactant [0126]-[0132], Table II); and

(g) repeating the sequence of steps (c), (d), (e), (f) to deposit a plurality of metal nitride monolayers which form a composite layer that fills said opening (see [0126]-[0132], Table II); and

(h) planarizing said composite layer to be coplanar with said dielectric layer (see Figure 13 and [0159]).

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In re claim 13, Raaijmakers et al. disclose the method wherein said dielectric layer is PSG, BPSG, or a low k dielectric material with a thickness between about 1000 and 10000 Angstroms (see [0054] and [0055]).

In re claim 14, Raaijmakers et al. disclose the method wherein the opening is a contact hole, via, or trench and has a width that is about 100 nm or less (see [0061]).

In re claim 15, Raaijmakers et al. disclose the method wherein the temperature of said ALD process chamber is between about 250°C and 750°C and the pressure in said ALD process chamber is maintained in a range from about 0.1 to 50 Torr 9 see [0126] and Table II)

In re claim 16, Raaijmakers et al. disclose the method wherein said metal precursor is $\text{Ti}(\text{OCH}(\text{CH}_3)_2)_4$, tetrakis(dimethylamido)titanium (TDMAT), tetrakis(diethylamido)titanium (TDEAT), or tert-butyylimino-tris(diethylamino)tantalum (TBTDET) (see [0115]).

In re claim 24, Raaijmakers et al. disclose the method wherein the planarization is performed with a chemical mechanical polish (CMP) step (see [0159 and Figure 13).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 5-9 and 18-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raaijmakers et al. (U.S. Patent Appl. 2001/0054769).

In re claim 5-8 and 18-21, Raaijmakers et al. disclose the method as claimed and recited including the method transporting the metal precursor gas by an inert gas (see [0127], and wherein the inert gas purging of the ALD process chamber is comprised of flowing argon, helium or N₂ with a period of about 0.1 to 10 seconds (see Table II and [0127]); and wherein the nitrogen containing reactant is comprised of NH₃, N₂H₄, N₂ and is flowed for a period of about 0.1 to 3 seconds (see Table II and [0127]), but does not disclose the method wherein said metal precursor is flowed into said ALD process chamber at a rate of about 500 to 10000 standard centimeters per minute (sccm) for a period of about 0.1 to 3 seconds, or wherein the inert gas is flowing at a rate from about 500 to 10000 sccm during flowing of the metal precursor, and during the inert purge, and wherein the nitrogen containing reactant has a flow rate of about 500 to 10000 sccm.

The examiner notes that Applicant does not teach that the flowrates as claimed and length of pulse of the metal precursor solve any stated problem or are for any particular purpose. Therefore, the flowrate and length of metal precursor pulse lack criticality in the claimed invention and does not produce unexpected or novel results. The examiner notes that Raaijmakers et al. teach that the method in Table II is exemplary only and that one of ordinary skill in the art can "modify, substitute or otherwise alter deposition conditions of different reaction chambers and for different selected conditions to achieve saturated, self-terminating phases at acceptable

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deposition rates" ([0125]). Further, Raaijmakers teach that "the ALD processes described herein are relatively insensitive to pressure and reactant concentration as long as the reactant supply is sufficient to saturate the trench and via surfaces" ([0126]). Therefore, the examiner notes that the flow rates and pulse times depend on the size of the deposition chamber as well as other variables such as precursor utilized. It would have been obvious to one of ordinary skill in the art at the time the invention was made to flow the metal precursor is flowed into said ALD process chamber at a rate of about 500 to 10000 standard centimeters per minute (sccm) for a period of about 0.1 to 3 seconds, wherein the inert gas is flowing at a rate from about 500 to 10000 sccm during flowing of the metal precursor, and during the inert purge, and wherein the nitrogen containing reactant has a flow rate of about 500 to 10000 sccm because it is a matter of determining optimum process conditions by routine experimentation with a limited number of species of result effective variables. These claims are prima facie obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. In re Woodruff, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also In re Huang, 40 USPQ2d 1685, 1688 (Fed. Cir. 1996)(claimed ranges or a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art). See also In re Boesch, 205 USPQ 215 (CCPA) (discovery of optimum value of result effective variable in known process is ordinarily within skill or art) and In re Aller, 105 USPQ 233 (CCPA 1995) (selection of optimum ranges within prior art general conditions is obvious).

In re claim 9 and 22 Raaijmakers et al. disclose the method further comprised of a generating a plasma to assist in the reaction between the nitrogen containing reactant and the metal precursor (see [0110] and column 10, lines 15-35 of 6,511,539, incorporated by reference).

Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Raaijmakers et al. (U.S. Patent Appl. 2001/0054769) in view of Kim et al. (U.S. Patent No. 6,270,572).

Raaijmakers et al. disclose the method as claimed and rejected above, but does not disclose the method wherein performing a film thickness measurement after several repetitions of the ALD process to determine if an acceptable thickness of said composite layer has been achieved. Kim et al. disclose the method performing a film thickness measurement after several repetitions of the ALD process to determine if an acceptable thickness of said composite layer has been achieved (see column 6, lines 30-35). It would have been obvious to one of ordinary skill in the art at the time the invention was made to perform a measurement of the thickness of the layer as Kim et al. teaches in the method of Raaijmakers et al. in order to ensure a sufficiently thick metal nitride to serve a barrier function in the dual damascene structure (see [0123]).

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Raaijmakers et al. (U.S. Patent No. 6,78,704) disclose the method of utilizing $Ti(OCH(CH_3)_2)_4$ for ALD deposition of TiN.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Kennedy whose telephone number is (571) 272-1672. The examiner can normally be reached on Mon.-Fri. 9:30-6:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Michael S. Lebentritt can be reached on (571) 272-1873. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).


Jennifer M. Kennedy
Primary Examiner
Art Unit 2812

jmk